State of California
Department of Industrial Relations
Occupational Safety and Health Standards Board

Petition File No. 596

Board Staff Evaluation
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State of California
Gavin Newsom, Governor

INTRODUCTION

Petition File No. 596 (Petition) was received from Praveen Penmetsa, Chief Executive Officer, Monarch Tractor (Petitioner), on December 15, 2021. The Petition requests the Occupational Safety and Health Standards Board (Board) amend title 8, section 3441(b) to allow for the use of driver-optional tractors without a human operator stationed at the vehicular controls.

REQUESTED ACTION

The Petitioner requests that section 3441(b), regarding the operation of agricultural equipment, be amended to allow for an exception under the following conditions, which are based upon requirements from a temporary experimental variance (TEV) granted to the Petitioner by the Division of Occupational Safety and Health (Cal/OSHA):

> *Notwithstanding section 3441(b), self-propelled equipment is not required to have an operator onboard the vehicle when the following conditions are met:*
>
> - *The manufacturer certifies that the technology has gone through appropriate safety protocols in the following: Product development; Monitoring and testing of the technology; and the technology meets the operational requirements of the three*[sic] *stages listed below:*
> - *Stage 1 -- zero to 500 hours or one year of operation of the tractor technology with an operator on the tractor at all times, allowing for advancement to Stage 2 only if there are no close calls, incidents, injuries, or accidents;*
> - *Stage 2 -- an additional 500 hours of operation of the tractor technology and operation during all four seasons (summer, fall, winter, spring) without an operator on the tractor so long as an onsite remote operator was alerted whenever the tractor detects an obstacle, allowing for advancement only if there are no close calls, incidents, injuries, or accidents.*
> - *There are posted signs, visible from 50 feet during daytime or nighttime, at the entry and exit of every site where autonomous technologies are deployed, reading "Driver Optional Vehicle in Use";*
> - *The driver-optional vehicle shall be provided with a perception system capable of detecting and locating persons or other obstacles relative to the machine;*
> - *The driver-optional machinery shall be provided with a system capable of locating and positioning the driver-optional machinery as required for the operations involved while preventing unintended excursions beyond the boundary of the working area;*
> - *Emergency stop buttons shall be affixed at the outermost perimeter on both sides and the rear of the tractor, depressing the emergency stop buttons shall immediately initiate braking to stop the tractor; and*

- *The tractors shall come to a full stop before any human encroaches a 7-foot radius from the tractor, and the 7-foot clearance applies regardless of the agricultural operation or the implements attached to the tractor.* (Petition, p. 6).

PETITIONER'S ASSERTIONS

The Petitioner asserts:

- Autonomous and driver-optional machinery provides a multitude of benefits for the agriculture industry, including improved air quality, sustainability and food quality.
- One of the most tangible and significant benefits is improved farm worker safety.
- According to the Bureau of Labor Statistics, agriculture is the deadliest profession in the United States and in the State of California with roughly 40% more deaths per 100,000 workers than any other industry.
- Tractor accidents are a leading cause of serious injury, accounting for about one-third of farm fatalities annually.
- Autonomous operation removes the possibility for human error and harm to tractor drivers, and also allows farm workers to avoid fields when chemicals are sprayed, significantly reducing - if not eliminating - employee exposure to dangerous chemicals.
- It is unclear whether autonomous software operating automated machinery meets the operator standard, which has created confusion and ambiguity throughout the farming industry and among machinery manufacturers who are already deploying advanced technologies.

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH (Cal/OSHA) REPORT

Cal/OSHA's report dated April 7, 2022, recommends denying the Petition. Although Cal/OSHA agrees that the smart technologies of the tractor (e.g. anti-rollover, remote application of pesticides and proximity sensors on the power take-off device) can enhance worker safety when perfectly reliable, Cal/OSHA recommends that further substantiation of the technology through the completion of the current experimental variance be completed prior to the drafting of regulations for self-driving agricultural equipment.

STAFF EVALUATION

According to the Petition:

> Monarch Tractor is the world's first fully electric, driver-optional, smart tractor. It enhances farmers' existing operations and improves farm worker efficiency to help alleviate labor shortages and maximize yields. By enabling precise and emissions free 24/7 farm operations, Monarch Tractor is advancing wide scale implementation of regenerative, sustainable and organic agriculture. (Petition, p. 1).

Board staff met with representatives of the Petitioner and Yancy Yap of Cal/OSHA to discuss the Petition on March 9, 2022. The Petitioner explained that their driver-optional tractor performs the same operations and is equipped with the same basic safety features as a traditional diesel powered tractor, but includes smart technology, which increases the safety of the tractor beyond that of the traditional tractor.

The Petitioner stated that the smart tractor has the ability to detect and correct tractor instability, reducing the likelihood of a rollover accident. In the Petition, the Petitioner cites Bureau of Labor Statistics data, which indicate that tractors are a leading cause of injury and death on farms. When an operator is present, the smart technology helps to protect the operator and others in the area from injury. When the operator is not present, the tractor's ability to function autonomously removes the possibility of injury to the employee caused by the tractor.

The Board has previously considered a petition on the topic of autonomous vehicles in agriculture. On May 16, 2019, the Board denied Petition 571, submitted by Michael Pankonin on behalf of the Association of Equipment Manufacturers. Petition 571 similarly requested an amendment to section 3441(b) to specifically allow the operation of autonomous agricultural equipment without an operator present on the equipment.

On August 6, 2021, then Cal/OSHA Chief Douglas Parker approved a TEV for two employers in Northern California to operate the subject smart tractor in accordance with various mandatory conditions. The variance is valid for up to five years unless extended by Cal/OSHA.

Relevant Standards

Federal Standards

Federal agricultural regulations include general requirements for protecting employees from hazards created by moving machinery parts, as well as general equipment safety training requirements, but do not specifically address autonomous or driver optional equipment.

California Standards

Title 8, section 3441(b) along with other generic guarding and training standards exist, but none specifically address autonomous or driver-optional equipment. The California Department of Motor Vehicles has requirements for the operation of autonomous vehicles on public roads, but does not address agricultural use on private land.

Section 3441(b) reads as follows:

> *(b) All self-propelled equipment shall, when under its own power and in motion, have an operator stationed at the vehicular controls. This shall not prohibit the operator occupying or being stationed at a location on the vehicle other than the normal driving position or cab if controls for starting, accelerating, decelerating and stopping are provided adjacent and convenient to the alternate position. If the machine requires steering other than ground or furrow steering or operates at ground speeds in excess of two miles per hour, steering controls shall also be provided at the alternate location. Seedling planters and other similar equipment traveling at a speed of two miles an hour or less where a control that will immediately stop the machine is located at the operator's work station will satisfy this requirement.*
>
> *(1) Furrow guided self-propelled mobile equipment may be operated by an operator not on the equipment provided that all of the following are complied with:*
>
> *(A) The operator has a good view of the course of travel of the equipment and any employees in the immediate vicinity.*
>
> *(B) The steering controls, when provided, and the brake and throttle controls are extended within easy reach of the operator's station.*
>
> *(C) The operator is not over 10 feet away from such controls and does not have to climb over or onto the equipment or other obstacles to operate the controls.*
>
> *(D) The equipment is not traveling at over two miles per hour ground speed.*

Consensus Standards

ISO 18497:2018 “Agricultural machinery and tractors—Safety of highly automated agricultural machines—Principles for design” is a performance standard that lays out guidelines for the manufacture of highly automated agricultural machines (HAAM) and can be applied to a wide variety of equipment. The standard does not provide prescriptive requirements or specific benchmarks, but instead provides general principles to address the potential hazards.

For instance, in Section 4.2 “Principles for Protection,” the standard reads:

> *For ensuring an appropriate level of safety:*
>
> - *the HAAM shall be provided with a perception system capable of detecting and locating persons or other obstacles relative to the machine;*

- *the HAAM shall be provided with a perception system capable of locating and positioning the HAAM as required for the operations involved while preventing unintended excursions beyond the boundary of the working area;*
- *before each movement of the HAAM, it shall be ensured, by the safeguarding system, that there is no obstacle in the hazard zone;*
- *while performing highly automated operations, the HAAM shall, when an obstacle is detected in or enters the hazard zone, give an audible or visual alarm and enter its defined safe state;*
- *the HAAM shall be provided with the means to enable a local or remote operator to stop or start highly automated operation;*
- *the HAAM shall allow adequate supervision by a local or remote operator.*

Definitions are provided as well as a comprehensive list of additional requirements for the safe operation of the HAAM.

Various other consensus standards exist which could be helpful in crafting a standard to regulate HAAM, including ISO/TR 22100-4, "Safety of machinery – Relationship with ISO 12100 – Part 4: Guidance to machinery manufacturers for consideration of related IT-security (cyber security) aspects." According to the ISO website, the cyber security standard is designed to help machinery manufacturers identify and address IT security threats that can impact the safety of their product[1] (e.g. unauthorized activation or hacking of HAAM).

Staff Analysis

Driverless smart tractors were likely not envisioned in the mid to late 1970s when section 3441 was developed. The technologies mentioned in the existing regulation address traditional tractors where the operator sits in a seat on top of the tractor to access the machine controls. Tractors with an operator in a position on the tractor other than on the top of the tractor are also allowed under certain conditions.

The Petitioner questions whether the equipment's "wide array of sensors, telematics and sophisticated software" can function as the "operator" to meet the requirements of the existing standard. Although title 8 requirements do not specifically define an "operator"[2], it is reasonable to assume that they imply that a person is required to be stationed at the vehicular controls.

[1] https://www.iso.org/news/ref2365.html. Accessed 1/30/19.
[2] Section 3207 contains a definition for a "Qualified Person, Attendant or Operator", but the definition would likely not apply in the present situation.

However, the requirement to have an operator stationed at the vehicular controls may pose a concern when attempting to apply the regulation to emerging tractor technologies like those mentioned in the Petition because the vehicular controls may not be located on the tractor. Section 3441(b) does not specify whether an operator using a laptop or cell phone to monitor the tractor's operation complies with the regulation's requirement to "have an operator stationed at the vehicular controls." Such equipment may not have been contemplated at the time that the regulation was promulgated and the regulatory history is silent on the matter. The subsection may benefit from further clarification in regard to its application to driverless technologies.

The requirement found in section 3441(b) states:

> All self-propelled equipment shall, when under its own power and in motion, have an operator stationed at the vehicular controls. This shall not prohibit the operator occupying or being stationed at a location on the vehicle other than the normal driving position or cab if controls for starting, accelerating, decelerating and stopping are provided adjacent and convenient to the alternate position.

The plain language requires that controls be provided near the operator "on the vehicle," whether in the usual driving position or cab, or in an alternate position. The "normal" operating position for many autonomous tractors, however, is not on the vehicle itself.

Permitting the use of autonomous vehicles in agriculture does not necessarily equate to their use being uncontrolled or unregulated. Smart tractors can be used in hazardous jobs where typically only the operator is present, such as in mowing a field or spraying chemicals. In such work, removing the employee from exposure to noise, heat, and chemicals is understood to be the most effective strategy in the hierarchy of controls because the hazardous exposures are completely eliminated from the tasks[3]. Regulations regarding driverless tractors could be written to address their use in the absence of employees, in proximity to employees (e.g. seven or more feet away), and/or adjacent to employees.

In the Petitioner's present TEV, employees are not allowed to work within seven feet of the smart tractor. If employees come within the seven-foot boundary, the tractor is designed to come to a stop. Other employee warnings are present at different distances, including the slowing of the tractor when employees are detected within seven to 16 feet, and an audible and visual alert when employees are within 16 to 33 feet. Eventually, the Petitioner hopes to allow employees to work adjacent to the tractor while it is in full autonomous operation.

[3] https://www.cdc.gov/niosh/topics/hierarchy/default.html. Accessed 3/21/2022.

Title 8 does not contain requirements specific to autonomous vehicles in agriculture, yet the technology is becoming more prevalent in California. Emails with stakeholders indicate that several companies are developing or currently operating various forms of autonomous agricultural equipment in California, including the Petitioner through its TEV. Additionally, the Petitioner provided Cal/OSHA and Board staff with data showing that its driverless tractors detect workers thousands of times each month. Developing requirements for signage, visual and audio alerts, and general operation of the equipment is prudent so that employers can have a uniform set of expectations to follow and employees can have a uniform set of protections to rely upon.

Employee safety and health can also benefit by addressing training needs unique to exposures to autonomous equipment, such as identifying a piece of equipment operating autonomously and maintaining a safe distance from such equipment. Benchmarks for the operation and effectiveness of the equipment's sensors and alarms can be established with the input of the larger safety and health community in an advisory committee as well.

Existing regulations may be ambiguous in their application to autonomous agricultural equipment and because of the many forms in which such technology can appear, staff suggest that the following topics be considered for inclusion in an advisory committee discussion on the topic of autonomous vehicles in agriculture:

1. Means for alerting employees and others about the presence of the autonomous agricultural equipment in operation
2. Means for stopping the operation of the equipment in an emergency, including requirements for the redundancy of such systems
3. Benchmark requirements for detecting objects and employees in the path of travel
4. Requirements for the start and restart of machines in autonomous operation
5. Requirements for testing and maintenance of the sensors and alarms used to protect employees
6. Means to ensure the autonomous vehicle does not leave the desired work area or field
7. Requirements for operation and supervision of the equipment
8. Precautions necessary to prevent unauthorized interference or use of the equipment

STAFF RECOMMENDATION

Consistent with the foregoing discussion, Board staff recommends that Petition File No. 596 be **GRANTED** to the extent that Board staff are directed to convene an advisory committee to consider amending section 3441 as deemed necessary following a discussion inclusive of the above-mentioned topics. The Petitioner should be extended an invitation to participate in the advisory committee process.